Water Quality
Supplement 5.15

The pH Game

Purpose
To teach students about the acidity levels of liquids and other substances around their school so that they understand what pH levels tell us about the environment.

Learner Outcomes
The learner will
- Take measurements.
- Conduct analysis.
- Interpret findings.
- Understand interrelations in nature.

Overview
The pH game will engage students in the measurement of the pH of water samples, soil samples, plants and other natural materials from different places. Students will create mixtures of materials in order to collect different pH measurements.

Time
One class period for preparation. One class period for the game.

Materials
For each team (about 4 students):
- 20 pH strips
- 3 or 5 small cups
- Paper and pencil
- Labels with which to attach results to the results board

For the entire classroom:
- Results board for all teams (one line of pH levels from 2 to 9 for each team)
- Flip chart with rules
- Additional pH strips

Preparation
The teacher should prepare various acidic and alkaline mixtures/solutions of natural and processed materials. These solutions should be labeled with the ingredients and a letter, but not their acidic or alkaline characteristic. Examples of acidic solutions might include fermented grass, diluted and concentrated lemon juice, black coffee, vinegar, orange and soft drinks. Alkaline solutions include salt water, shampoo, baking soda, chlorine bleach, household ammonia and oven cleaner. Soil solutions produced by mixing water and local soil samples should be used as well as local water samples. The teacher can also produce solutions from materials found around the local school area, such as oil drippings from a vehicle, liquid in a discarded bottle, etc.

Background

The level of acidity (pH) significantly influences the vegetation and wildlife in an environment. The pH can be influenced by different factors. The main influences are the alkaline contributions from rocks and soils, the amount of water in the landscape and also human activities (traffic, buildings, paved surfaces, etc.). Acid rain may also have an important impact on water pH. It is important to understand these relationships. This simple activity will help your students to understand the interdependence of nature and human activities.

Note: Remind students of the difference between hypothesis and results. Encourage them to develop their hypothesis and find a way to test it with results. (Prepare some literature for them, invite an expert to the class, examine past measurements, etc.)

The Rules

- Explain to students the objective of the game is that each team identifies solutions that have a pH range of 2 to 9.
- The students should draw a horizontal pH scale line from 0 to 14, marking pH 7 as the neutral point. Each unit should be spaced at least 1cm apart. They should then draw a box underneath each pH unit from 2 to 9.
- Each team finds substances that have a pH corresponding to a box in the pH scale.
- The teacher draws the following matrix on the board. See the first matrix below.
- One point is awarded for each box filled, even if the team finds two samples with the same pH.
- Students should record all the information about the solution from the labels and the pH that they measured.
- When students are ready to submit a sample for the game results board, they show the teacher their notes and the sample. Together they measure the pH with a new pH strip. If the pH agrees with the students' previous measurement, the sample is approved and the points are added to the team's score. The table below is an example of results for different teams. See the second matrix below.
- The teacher gives a new pH strip for each sample added to the results board.

Matrix **pH Value**

Teams	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**

Matrix **pH Value**

Teams	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
Team 1	1		1			1	1		4
Team 2		1		1				1	3
Team 3	1				1		1		3
Team 4	1	1				1	1	1	5

Modifications for Academic Levels

Beginning

For a basic understanding use salt and sugar and explain to students that salty does not necessarily mean acid and that sweet does not necessarily mean alkaline. Cola soft drinks are good examples of sweet and very acid liquids.

Intermediate

Make the game more competitive. For instance, the team that finds or creates the first sample of a particular pH value receives five points; subsequently, samples for that pH level receive only one point. Make the game more difficult by limiting the sample sources to only natural materials. Limit the number of pH strips given to each group and set up a rule for buying a new one with game points.

Advanced

Ask the students which solutions should be added together to produce a neutral solution. Have them test their hypothesis by adding some of the labeled solutions together and recording the pH. Have the students quantify the neutralization capacity of different solutions. Relate this to buffering capacity (alkalinity) of water sample sites. Provide students with samples of solutions from other parts of your country (or of the world) and ask them to characterize how they influence pH differently. Conduct a similar analysis of samples from different geological layers or different areas of the community or study site.

Further Investigations

- Examine the water sample study sites for materials in soil, rocks and vegetation that influence the pH of the water.
- Try to identify and quantify influences that are not always present at the study site, such as precipitation or some event upstream of your sampling site.

Evaluation

After the game, sit with students around the results board and identify what samples they have found, share the samples found and the pH of the samples. Encourage students to present their own ideas about why different samples have different pH values. Emphasize differences among water samples from soils, rocks, artificial surfaces, lakes, rivers, cave pools, etc. Mention the acid neutralization capacities (alkalinity) of some rocks and the acidic influences of different materials. Ask them why it was difficult to find samples for some pH levels and easy to find others.

Acknowledgments

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